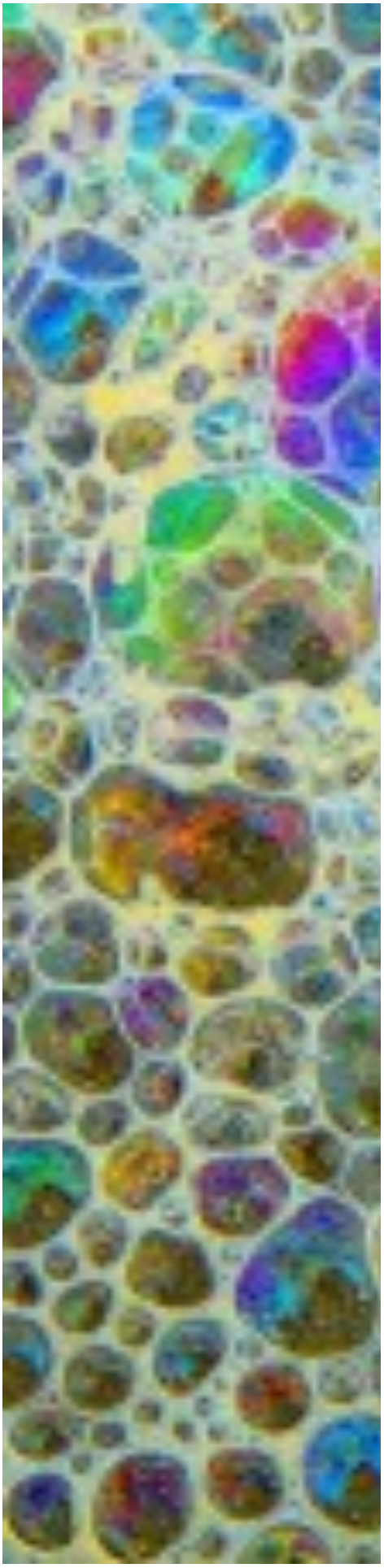
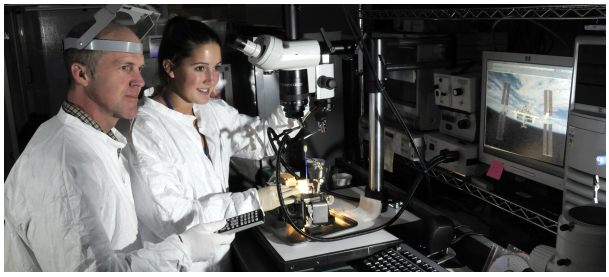
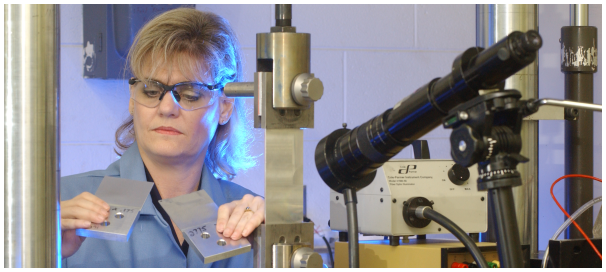


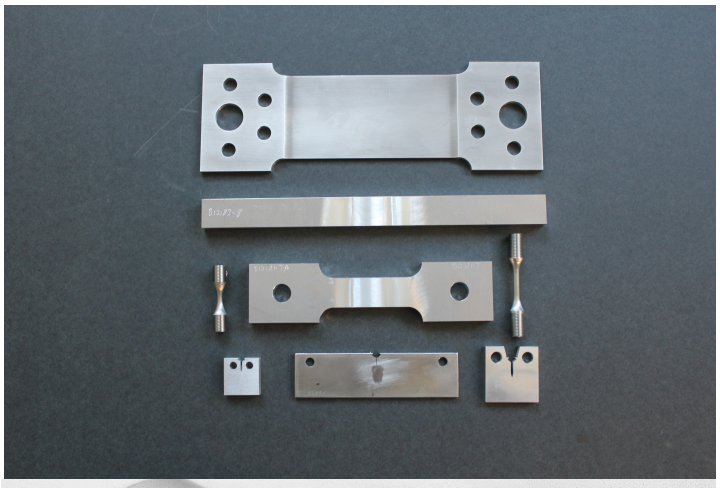
National Aeronautical and
Space Administration

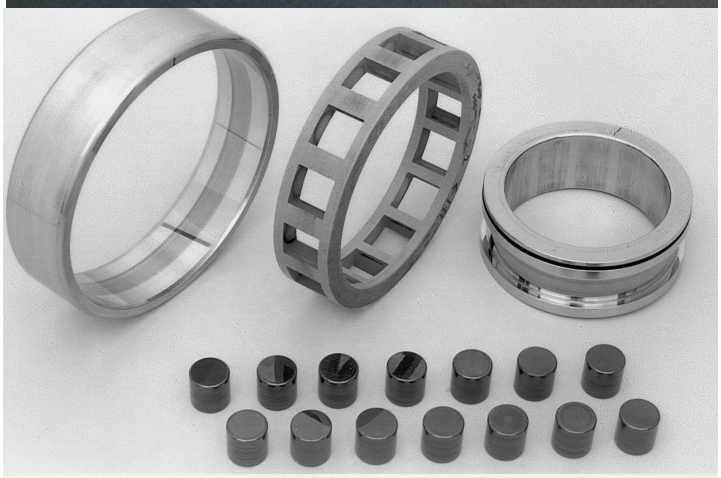




Marshall Space Flight Center

materials test branch





EM 10 Materials Test Branch

The Materials Test Branch resides at Marshall Space Flight Center's Materials and Processing laboratory and has a long history of supporting NASA programs from Mercury to the recently retired Space Shuttle. The Materials Test Branch supports its customers by supplying materials testing expertise in a wide range of applications. The Materials Test Branch is divided into three Teams, The Chemistry Team, The Tribology Team and the Mechanical Test Team.

Our mission and goal is to provide world-class engineering excellence in materials testing with a special emphasis on customer service.

Materials Test Branch Contacts

Gail H. Gordon, Chief
Gail.H.Gordon@nasa.gov
256-544-2726

James H. Perkins, Deputy
James.H.Perkins@nasa.gov
256-544-2634

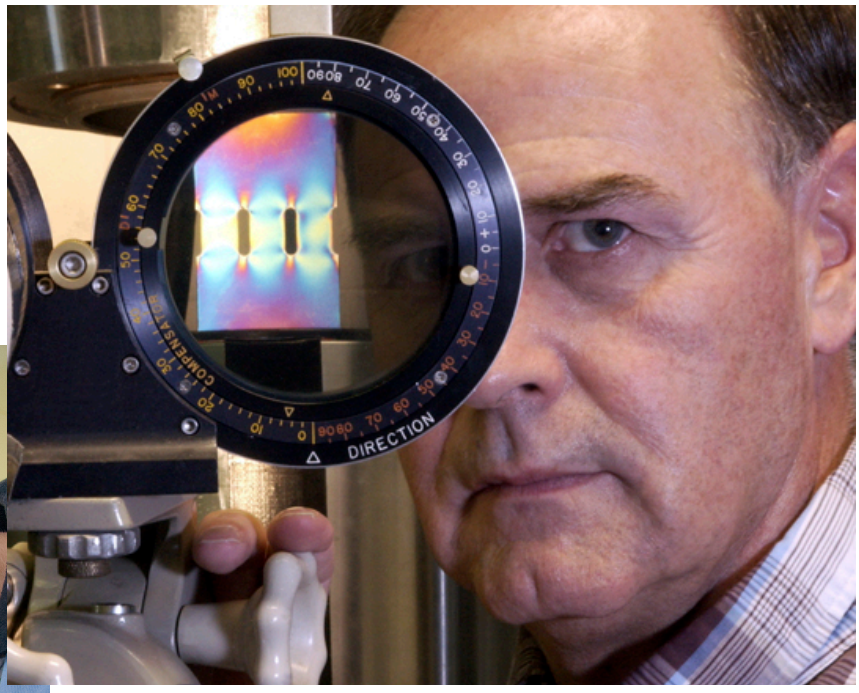
EM 10 – Mechanical Test Team

The Mechanical Test Team is responsible for performing all types of mechanical testing. Capabilities for the performance of both standard ASTM and non-standard mechanical tests in environments from elevated down to cryogenic temperatures are available. Engineers are available to provide guidance in plan development, specimen and cut-plan design. Capability is also available for manufacturing special test coupons by skilled technicians on site. The largest scope for evaluation of stress and fracture issues is offered here. Materials performance is evaluated in extreme conditions using simulated in-process or service induced heating, cooling, or loading with computerized data acquisition. U.S. Government and industry specifications are supported for any standard test type. Custom tests such as special component testing for simulated service loads and environments are also designed and conducted. This facility is ISO 9001 certified and consulting services are offered in all areas.

Mechanical Test Team Contact

Tina W. Malone, Team Lead
Tina.W.Malone@nasa.gov
256-544-2593

Examination of the machined notch on a compact tension specimen just before beginning a fracture test



Test technician peers through a light polarizing filter to observe results from a photo-stress test

Mechanical Materials Testing

Twenty mechanical test systems are used to apply force from 0.05 to 900 kN (0.01 to 200 kip) at temperatures from –268 to 1,093 °C (–450 to 2,000 °F) with computerized data acquisition. Tests are run in air, gas or liquid nitrogen, and helium. Capabilities include: Standard ASTM mechanical tests, simulated service tests, fastener tests, and 3-D image correlation which measures surface coordinates, displacements, velocities, and strain values and rates for static or dynamically-loaded coupons.

Materials engineer evaluates a test assembly at the Hydrogen Test Facility

Materials engineer assembles the sample fixture on a cryogenic mechanical test system (20 kips, high pressure)

Hydrogen Test Facility

The hydrogen test facility is a unique national resource used to run an extensive range of tests in hydrogen, with procedures developed on demand. This facility was the first in the world to run high-pressure cryogenic permeability tests in liquid hydrogen at pressures up to 2,068 kPa (300 psi). Custom test systems are operated in eight structurally reinforced test cells screening for property changes under different combinations of stress, pressure, and ambient to extreme temperatures.

EM 10 - Chemistry Team

The Chemistry Team provides an extensive suite of capabilities, from basic analytical and environmental chemical analysis to tests required to qualify materials for space flight. Fundamental analyses includes measurement of chemical, crystallographic, thermal, and thermophysical properties of materials critical to the success of NASA's programs, as well as pinpointing contaminants that may be detrimental to mission success. The team also conducts a comprehensive set of combustion, toxicity, and thermal vacuum tests required for materials that are candidates for spaceflight.
The Analytical and Environmental Chemistry Laboratories, the Environmental Gas Laboratory, the Materials Combustion Research Facility, and the Ionic Liquids & Exploration Technologies Development Laboratory carry out distinct but complementary duties to offer a unique combination of materials test options that support both standard and customized needs. Because new tests and techniques are often required when selecting the best materials for special applications, the teams' chemists and engineers routinely design or customize testing for NASA, other Government agencies, and industry.

Chemistry Team Contact

Eddie Davis, Team Lead
Eddie.Davis@nasa.gov
256-544-2490

A sample is inspected before analysis for Total Organic Carbon content

Preparing sample for Inductively Coupled Plasma (ICP) Analysis

Analytical and Environmental Laboratory

Chemical and physical property determinations made of samples using wet lab and instrumental techniques.

Routinely performs a wide range of environmental tests on a variety of matrices including drinking water, ground water, waste water, liquid hazardous waste and solids.

The laboratories are accredited by the Environmental Protection Agency's National Environmental Laboratory Accreditation Program (NELAP) and is the only NELAP-accredited Federal laboratory in the State of Alabama. This means that data produced in the laboratories is defensible in courts of law.

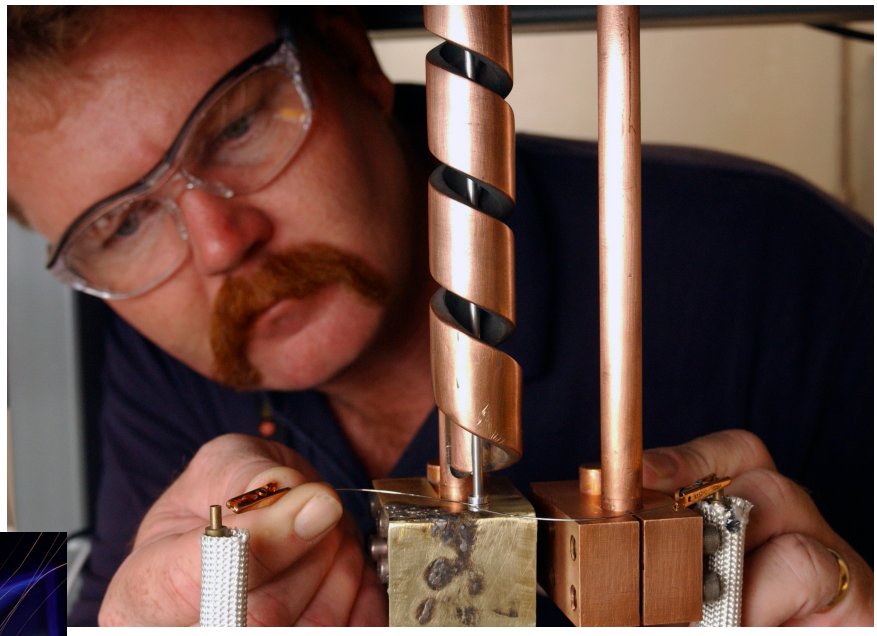
Injecting a gas sample into a Gas Chromatography System to identify any toxins

Toxicity Laboratory & Environmental Gas Laboratory

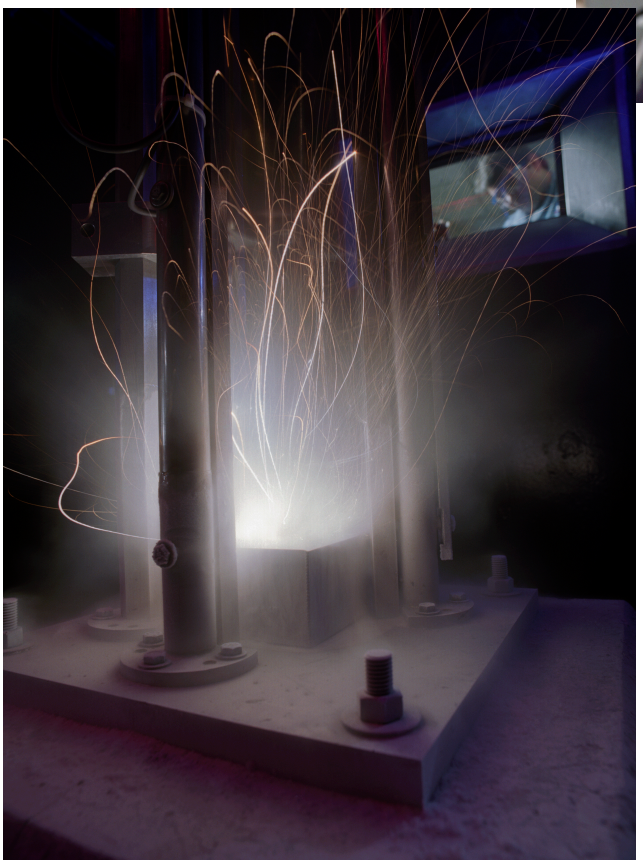
Determines offgassed compounds with potential for adverse reactions and health affects on exposed personnel.
The laboratory determined the safest insulation material for astronaut contact.

Tests facility gases & cryogenic liquids, for purity, particulates, and moisture content. Verifies that clean rooms and flow benches across the installation are functioning within specified parameters.

Loading flight hardware into a sealed chamber for toxicity testing



Metal rod being loaded into the induction coil of the Heated Promoted Ignition Tester

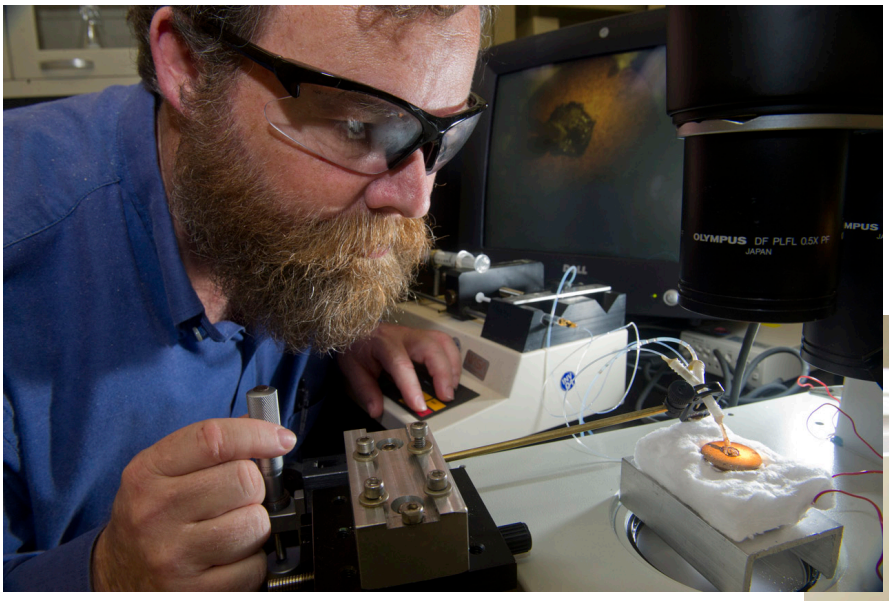


Explosion in liquid oxygen caused only by a piece of metal striking a sample immersed in oxygen

Oxidizer Compatibility & Combustion Laboratory

Screens materials for burn resistance in oxidizers (oxygen, nitrous oxide, hydrogen peroxide). Metals readily burn in high-pressure oxidizers. System safety requires utilizing the most burn-resistant metals. This testing found the most burn resistant space suits for astronauts to wear on orbit

Determines the potential for materials to ignite by mechanical impact in oxidizers. Materials can ignite by impact in an oxidizer environment with some ignitions leading to explosions. System safety requires utilizing the most ignition-resistant materials. This testing determined that ceramic bearings are superior to metal ones in oxygen systems.



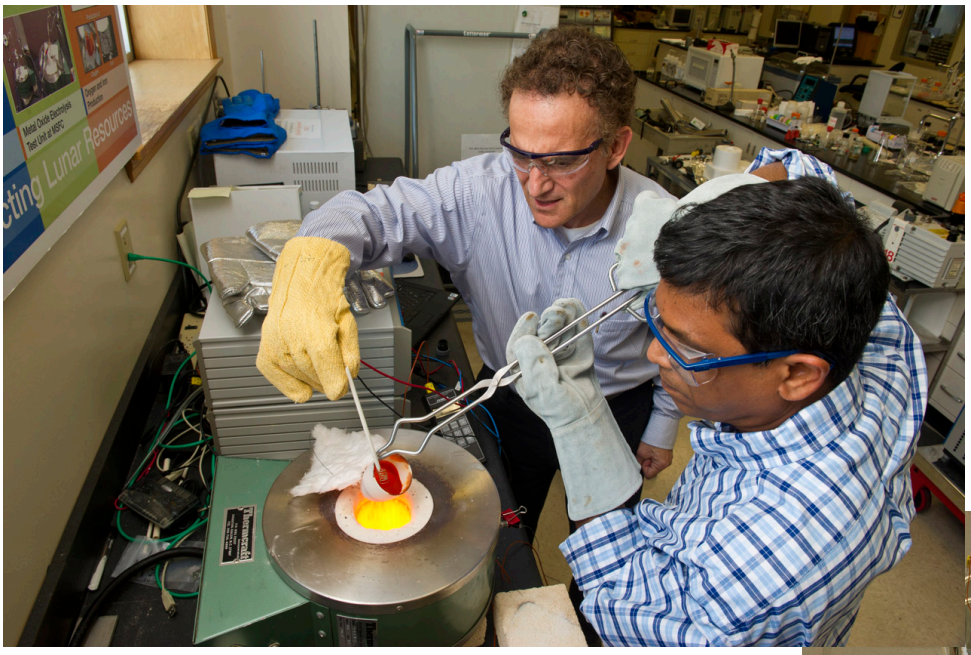
Chemical Drill - Using Ionic Liquids to dissolve Lunar Regolith Simulant

Ionic Liquids & Exploration Technologies Development Laboratory

Ionic Liquids are organic salts that are liquid at room temp. Because of low volatility, low flammability, and extreme versatility, they show great promise as next generation of "green" chemical reagents.

Ongoing projects:
Patented Ionic Liquid Epoxy developed for use as matrix of carbon composite cryo-tanks – very tough at low temps.
Acidic Ionic Liquids dissolve extraterrestrial soil to extract oxygen – can be regenerated while plating out the free metals
Specific Ionic Liquids dissolve cellulose to form rayon fibers; once carbonized, can be used by NASA, Air Force and Army in rocket nozzles, insulation and ablatives (critical technology need)

Lunar Regolith Simulant prior to extraction of oxygen and metals using Ionic Liquid (set-up under hood)



Scientists melting fluxed simulated lunar soil

Microwave Research and Molten Oxide Electrolysis

Microwaves can be used to extract water or other volatiles from planetary bodies for propellant, life support, and radiation protection. This energy can penetrate soil (regolith) and heat from the inside out to capture volatile resources at different depths, with no digging or excavation, less dust creation and lower power requirements than other processes.

Molten Oxide Electrolysis involves melting fluxed lunar, planetary, or asteroidal soil and performing electrolysis to yield oxygen and metals. Oxygen produced by this process could be used for breathing and for rocket propellant. The metals could be used as a basis for in situ manufacturing.

Survey of Radio Frequency leakage from experimental Microwave Vacuum Chamber

EM 10 – Tribology Test Team

Tribology is the study of friction, lubrication, and wear of surfaces in relative motion. The Tribology Team has ASTM test equipment for evaluating oils, greases, dry film lubes, and coatings on materials. Test equipment includes ASTM spec Shell Four Ball, Pin and V-block, Block on Ring, and Rolling Contact Fatigue testers. The Team also has many years of bearing research and analysis experience using computer software codes.

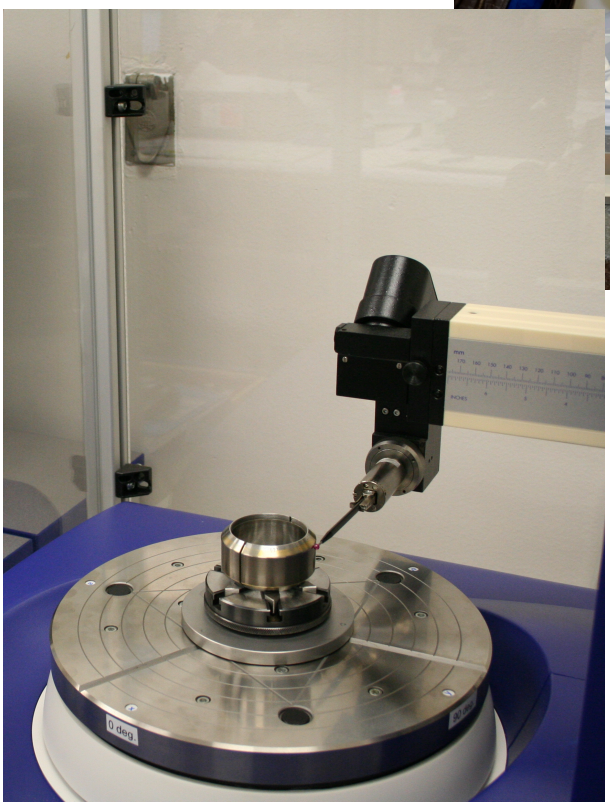
The Metrology Lab is a vital part of the Tribology Team. It is a unique agency resource in which high precision measurements are performed. This Lab has highly accurate dimensional and surface measuring equipment used to verify manufacturing specifications or in failure investigations. Microscopic and high definition photo capability is used to document results of inspections.

The Tribology Team has demonstrated its capabilities over years of Shuttle and Space Station tasks. Future space flight programs will depend on this team to ensure the successful operation of mechanical systems.

Tribology Test Team Contact

Howard G. Gibson, Team Lead
Howard.G.Gibson@nasa.gov
256-544-2513

Astronauts visit the Metrology Lab to inspect Solar Array rotary joint trundle bearing assemblies



High precision measurement of roller surface from trundle bearing assembly

Metrology Lab

The Metrology Lab at MSFC was vital in the examination of trundle bearing rollers from the Space Station Solar Array Rotary Joint (SARJ). Twelve assemblies from the Station were brought to EM10 and each one inspected to determine the cause of excessive vibration and high torque readings. From the inspections, a root cause was found and a solution derived to keep the solar panel assembly working. Astronauts from STS 126 visited MSFC to inspect the trundle bearings and to be briefed on the results.

Rolling Contact Fatigue Testing of wear resistant bearing materials

Tribology Laboratory

Rolling contact fatigue (RCF) testing of bearing materials in EM10 led to the development and use of Silicon Nitride rolling elements in high speed cryogenic bearings. This material had excellent fatigue resistance in the RCF test rigs and was installed into bearings that were tested at MSFC. The results from these bearing tests led to the use of the Silicon Nitride hybrid bearings being installed into the turbopumps on the Space Shuttle and flown on missions. These hybrid bearings with silicon nitride rolling elements are now commercially available from bearing suppliers.

Tribology Team assembling test rig for turbopump seal testing

National Aeronautical and Space Administration

George C. Marshall Space Flight Center
Huntsville, AL 35812

www.nasa.gov